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NAMRL Technical Memorandum 92-2

**AN AUTOMATED VERSION OF THE
DICHOTIC LISTENING TEST:
HARDWARE, SOFTWARE, AND
PROCEDURAL DETAILS**

G. B. Thomas, A.H. McCardie, and D. H. Lewis

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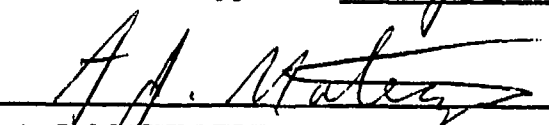
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13. ABSTRACT (Maximum 200 words) Hardware, software, and procedural details are presented for creation of a personal computer-based dichotic listening test. The source code is in Microsoft QuickBasic 4.5 and incorporates subject instructions, a practice-to-criterion routine, and automated stimuli presentation and scoring. The original computer platform was an 80286-based computer with a VGA card but the code has been tested with 80386 and 80486 microprocessors and various video modes with no problems. The stimuli are digitized analog signals and are presented through Antex processing cards. Source code and stimuli files are available from the authors.				
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SUMMARY PAGE

THE PROBLEM

An automated version of a dichotic listening test that: (a) operated on a 80286-based computer; (b) provided data that were compatible with data gathered with a manually administered version; (c) contained a practice-to-criterion procedure; and (d) could be administered with a minimum of experimenter intervention could not be located in the scientific literature. A suitable test version was required to fulfill research needs centering around the development of new hearing standards for naval aviators.

FINDINGS

A suitable microcomputer-based, automated version of a dichotic listening test was developed, tested, and refined to the point where all experimental requirements were met. The source code is provided and copies of executable code and stimulus files are available from the authors.

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INTRODUCTION

The dichotic listening test (DLT) has been utilized as a measure of selective attention for decades and has found application in both clinical and applied settings. The dichotic listening test paradigm has been of particular interest to researchers attempting to develop methods for selecting and assigning student aviators and for retaining aviators of advancing age. Gopher and Kahneman (1) and North and Gopher (2) were the first to note the relationship between measures of attention and flight performance in the Israeli Air Force. Griffin and his associates (3-5) studied the DLT in conjunction with a concurrent psychomotor task in the U.S. Navy and found it to be of use in predicting primary flight grades (6). We at the Naval Aerospace Medical Research Laboratory have incorporated the DLT in a battery of tests designed to assess the auditory fitness of aviators (7). The purpose of this test battery is to provide flight surgeons with additional information regarding higher auditory functioning to supplement (or supplant) the currently available pure-tone audiogram and Whispered Voice Test measures.

During the development of the test battery, we evaluated several existing methods (both manual and automated) of administering the DLT and found none that met all of our requirements. These requirements included stimulus and response compatibility with the hundreds of data points that we had gathered earlier by manual test administration, the capability of utilizing an 80286 (or 80386) microprocessor-based host computer to administer and score the test, instructions which the vast majority of subjects understood without experimenter intervention, a perform-to-criterion practice session, and provisions for the correction by the subject of erroneous responses.

The purpose of this technical memorandum is to make this automated version of the DLT available to other investigators. The appendix contains the source code (written in Microsoft QuickBasic v4.5) and is available in compiled form on magnetic media from the authors upon request. The digitized stimuli are similarly available upon request.

METHOD

EQUIPMENT

The original source code was written in Microsoft QuickBasic on a Hewlett-Packard Vectra (Model 23; 80286 microprocessor) but has been tested on other 80286-based machines to verify BIOS interrupt compatibility. Although not tested at the time of this writing, the code should also be 100% compatible with computers based on the 80386 and 80486 microprocessor (given the advertised downward compatibility of these microprocessors). The code has been tested and is compatible with various video modes (e.g., MGA, CGA, EGA and VGA) with only minor (if any) modifications. A numeric co-processor is not required.

The only computer hardware requirement beyond the basic computer is a D/A-A/D conversion board. This board should be capable of the virtually simultaneous presentation of two outputs, be able to sample at a 16-kHz rate, and should contain all the necessary signal conditioning circuitry onboard. The two single-channel Antex VP-620E A/D-A/D boards were chosen because of their optimized onboard signal conditioning circuitry and the availability of sophisticated driver software.

The output of the D/A boards is via RCA plugs, which are patched to a two-channel L-pad to control signal level before being routed to a pair of Koss Pro-4AAA headphones. The Koss headphones were chosen because of their comfort and because of the essential equivalency of their left and right transducers (< 1 dB (SPL) across several samples). Other brands or models might require a pair of independently controllable L-pads to equate the left and right earphone channels. Equal amplitude left and right channels are critical with the DLT and should be verified with a sound level meter and artificial ear.

MATERIALS

The original analog speech signals were created by the Central Institute for the Deaf, St. Louis, Missouri, and were utilized in our early manual administrations of the DLT. The master tape was digitized (by the Antex D/A-A/D board) and stored on the host computer's hard drive. Sampling at a 16-kHz rate requires 5.6 MB of storage space for the entire digitized test session. (Signals sampled at 8 kHz require 2.8 MB of storage and result in little audible difference from the 16-kHz rate.)

The speech tape utilized in the present version of the DLT is somewhat different from other versions. To increase the difficulty of the test and, thereby, increase the variance between subjects (and shorten the number of required trials), an interfering stimulus accompanies the presentation of each test stimulus. This interfering stimulus is actually a single utterance of backward-played speech and, though unintelligible and of a different spectrum than the test stimuli, serves to demand a greater degree of attention on the part of the subject. Because of this interfering stimulus, we have been able to reduce the number of test trials from a previous minimum of 24 to a total of 12 without loss of sensitivity. Stimuli are presented at a level of 84 dB (SPL) at the ear, and the interstimulus interval is constant at 700 ms.

PROCEDURE

The basic DLT task requires the subject to pay attention to the signal occurring in a "target" ear while attempting to ignore signals occurring simultaneously in the opposite ear. In addition to this interchannel attentional requirement, subjects must also exercise intrachannel attention to the target ear stimuli, which are occurring concurrently with the backward speech interfering sounds. A further level of processing is required in that once the target ear stimuli are received, they must be categorized as being either a letter of the alphabet or a number. Only numerical stimuli are to be recorded on the response screen by the subject. A given DLT trial is divided into two parts, the first part requiring five responses and the second part requiring four responses. The target ear is identified with a "RIGHT" or a "LEFT" command at the beginning of each part and indicates to the subject to which ear he is to attend. The target ear commands before each part within a trial can specify the same ear or opposite ears. Again, the subject's task is to record (via numerical keypad on the computer keyboard) only the numbers which occur in the target ear. Table 1 further illustrates the procedure:

Table 1. Sample DLT Trial (Correct Responses are Underlined)

<u>Part 1</u>	<u>Part 2</u>
BOTH ears: TRIAL 1 RIGHT (backward speech...)	LEFT (backward speech...)
LEFT ear: E P N 4 S Y 8 Z 5 U C V R 9 I B	G K <u>6</u> <u>2</u> <u>4</u> <u>1</u>
RIGHT ear: S <u>2</u> X A R <u>7</u> L <u>3</u> T Q J M <u>6</u> <u>1</u> K	J R 3 8 9 5
TIME----->	

Before beginning a test session, each subject is seated at the computer and reminded of the color coding of the earphones (i.e., the red earphone is fitted on the right ear). The subject is then left alone to read the instructions on the computer screen and begin the test session (by pressing the space bar). (The verbatim instructions are included in code in the appendix.) Prior to the formal gathering of test responses, the subject is given one demonstration trial during which he simply listens while the computer displays the correct responses on the screen. Figure 1 is an illustration of the computer response screen as it appears to the subject. The subject is then presented the same trial and is required to enter the responses. He is

permitted two attempts to attain a perfect score on this initial practice trial. If the subject fails on both of these attempts, a second practice trial is then presented, and the subject is given three opportunities to score perfectly. Should the subject fail to attain at least one perfect trial, the practice session is terminated and a message appears on the screen requesting the subject to seek the assistance of the experimenter. The experimenter checks the headphones for proper ear mounting and restates the salient aspects of the instructions. The subject is then given another opportunity to score perfectly on the practice items. A failure to provide a perfect score on the second attempt results in a termination of the test session. When the subject scores perfectly on one of the practice trials, the test immediately proceeds to the first test trial and experimental data collection begins. Throughout the test session, a "+" mark indicates the active response box; the subject is able to correct his responses by the use of the "Backspace" key.

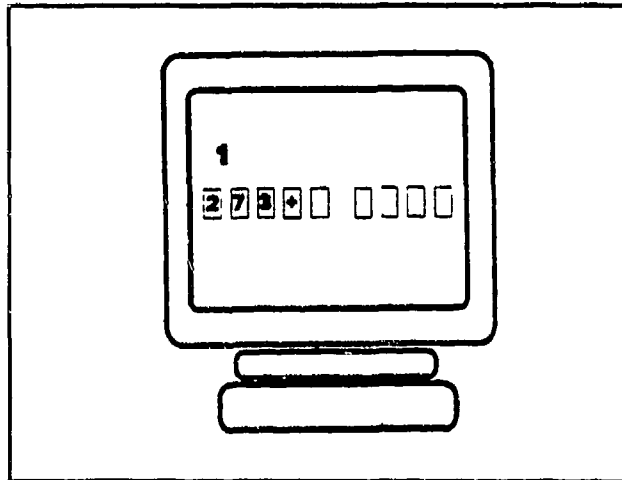


Figure 1. DLT Response Screen

Because the test session is, in large part, subject-dependent (i.e., the time to read the instructions, the number of practice trials required to reach the criterion, the frequency with which responses are corrected by the subject, etc.), test duration varies, but most (i.e., an estimated 90+%) subjects complete the entire DLT session in 8-10 min. In addition, the investigators estimate that fewer than 10% of subjects will have difficulty understanding the instructions and require experimenter intervention.

SCORING

At the conclusion of the test session, the experimenter can initiate the automatic scoring of the subject's responses and display summary results on the computer screen (the scores are automatically stored to a file of the experimenter's choosing). A number of errors can occur during a DLT session including errors of omission, commission, and transposition ("correct" numbers intruding from the non-target ear can never occur because the target and non-target ears never have numbers in common on a given trial). As might be expected, there have been discussions about the most effective way to score responses on the DLT (e.g., 8; Griffin, G. R., Naval Aerospace Medical Research Laboratory, Pensacola, FL, personal communication, July, 1989).

Because of the sequential nature of the DLT, errors of transposition necessarily occur in the presence of errors of omission and commission. That is, if an error of omission or commission occurs, all succeeding numbers are out of their correct position (and, therefore, under some scoring schemes, recorded as errors) even though they were correctly heard. The scoring scheme we adopted de-emphasizes errors of transposition and, instead, emphasizes errors of omission and commission. In brief, the scoring algorithm checks to see if the recorded number is in the position it is supposed to be or is in either adjacent position.

The algorithm will allow responses to be misplaced by exactly one position in either direction (except the first and last numbers in each part, which have either no predecessors or successors, respectively); otherwise, an error is recorded. Responses in Parts 1 and 2 are scored identically. The source code underlying this algorithm is included in the appendix.

DISCUSSION

Over 200 subjects have completed the present version of the DLT, and we have concluded that further refinement would result in insignificant improvements, at least in terms of our requirements. Perhaps the most challenging aspects of the development of any totally automated task is the creation of subject instructions that are completely understandable to all subjects. This is particularly true with a test like the DLT where the task is somewhat complicated, and the subjects have little in their personal experience that prepares them for the task requirements. We have found that instruction sets can be created that are understandable to 99 consecutive subjects, but the 100th subject will find them to be unfathomable. Given this apparent tautology, we have decided to continue with instructions detailed in the source code contained in the appendix. The other aspects of the test provided far less challenging problems although incorporating the manufacturer-supplied drivers for the the A/D-D/A boards into the source code and coordinating the outputs of the two boards to provide near simultaneous left/right presentation required some programming acrobatics. Nonetheless, the automated version has succeeded in providing mean scores ($n = 120$) that are not functionally different from those derived from the manually administered, two-channel audio tape-driven version ($n = 180$).

The details of this version of the DLT are being made available to other researchers so that they may avoid some of the frustrations and development pitfalls that we encountered. As noted earlier, copies of the executable code and stimulus files may be requested from the authors.

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APPENDIX

DEFINT A-Z

DIM code\$(1 TO 12), personal\$(1 TO 9)

DIM pracresult\$(1 TO 12), result\$(1 TO 12, 1 TO 9), rti(1 TO 100)

lef\$ = "TESTLF"

rit\$ = "TESTRT"

dir\$ = "C:\VOICE\"

vpbegin = 1

vpsetply = 3

vpstart = 4

vpstatus = 6

vpstop = 5

vpend = 9

baseline = 0

MAINBODY:

GOSUB INSTRUCTIONS

GOSUB PREPDATA

GOSUB GETSTUFF

CLS

GOSUB SETGRAPH

REM GOSUB INIT

GOSUB PRACTICE

15 GOSUB KILLVOICE

mid = 21: EOTEST = 32

CLS

LOCATE 10, 4: PRINT "This concludes the PRACTICE session."

LOCATE 23, 7

PRINT "PRESS THE SPACE BAR TO BEGIN"

t! = TIMER: DO UNTIL TIMER > t! + 2: LOOP

GOSUB READKEY

GOSUB PREPDATA

GOSUB CHOOSESPEECHFILE

GOSUB PLAYTEST

t! = TIMER: DO UNTIL TIMER > t! + 2: LOOP

FOR item = 1 TO 12

I& = FRE(0)

work\$ = STR\$(item)

work\$ = RIGHT\$(work\$, LEN(work\$) - 1)

GOSUB DRAWSCREEN

LOCATE 11, 17: PRINT "TEST " + work\$;

GOSUB READNWRITE

NEXT item

t! = TIMER: DO UNTIL TIMER > t! + 3: LOOP

SCREEN 2

SCREEN 0

GOSUB KILLVOICE

```

GOSUB WRITEDATA
CHAIN "a:basic\" + LEFT$(code$(current), 4)
END

```

PLAYTEST:

```

id1 = 1
id2 = 2
port1 = &H280
port2 = &H180
useint = 3
CALL vp620(id1, port1, useint, vpbegin)
CALL vp620(id2, port2, useint, vpbegin)
sr = 0
CALL vp620(id1, lftfile$, sr, vpsetply)
CALL vp620(id2, ritfile$, sr, vpsetply)
t! = TIMER: DO WHILE TIMER < t! + 2: LOOP
CALL vp620(id1, vpstart)
CALL vp620(id2, vpstart)
RETURN

```

GETSTUFF:

```

OPEN "b:battery" FOR INPUT AS #1
FOR index = 1 TO 12
    INPUT #1, code$(index)
NEXT index
CLOSE 1
filename$ = "b:info\sub" + code$(1) + ".dat"
OPEN filename$ FOR INPUT AS #1
FOR index = 1 TO 9
    INPUT #1, personal$(index)
NEXT index
CLOSE 1

```

RETURN

CHOOSESPEECHFILE:

```

CLS
FOR index = 2 TO 12
    filename$ = LEFT$(code$(index), 4)
    IF filename$ = "DLT2" THEN current = index + 1
NEXT index
test$ = MID$(code$(current - 1), 6, 2)
lftfile$ = dir$ + lft$ + test$ + ".spc"
ritfile$ = dir$ + rit$ + test$ + ".spc"

```

RETURN

SETGRAPH:

```

SCREEN 1
CLS

```

RETURN

DOTEXT:

```

LOCATE x, y

```

```
PRINT num;  
RETURN
```

```
READKEY:
```

```
DO  
    ch$ = INKEY$  
    LOOP WHILE ch$ <> ""
```

```
ch$ = ""  
DO  
    ch$ = INKEY$  
    LOOP WHILE ch$ = ""
```

```
RETURN
```

```
DRAWSCREEN:
```

```
LINE (1, 1)-(320, 200), 0, BF  
x1 = 36: y1 = 99  
WHILE x1 < 260  
    x2 = x1 + 14  
    y2 = y1 + 16  
    LINE (x1, y1)-(x2, y2), 3, B  
    x1 = x1 + 24  
    IF x1 = 156 THEN x1 = 180  
WEND  
'LOCATE 16, 10: PRINT "PART 1"  
'LOCATE 16, 26: PRINT "PART 2"  
PRESET (159, 20)
```

```
RETURN
```

```
READNWRITE:
```

```
index = 1  
x = 6: ypos = 14  
LOCATE ypos, x: PRINT "+";  
DO  
    ch$ = INKEY$  
    IF ch$ = "" THEN  
        GOSUB CHEKSTAT  
        IF tim = mid THEN  
            LOCATE ypos, x: PRINT " ";  
            x = x + 4  
            index = 6  
            LOCATE ypos, x: PRINT "+";  
        ELSEIF (tim = EOTEST AND hun > 90) OR s = 3 THEN  
            DO: a$ = INKEY$: LOOP WHILE a$ <> ""  
            RETURN  
        END IF  
    ELSEIF ch$ = CHR$(8) AND x > 6 THEN  
        LOCATE ypos, x: PRINT " "  
        x = x - 3  
        index = index - 1  
        IF x = 21 THEN x = 18  
        LOCATE ypos, x: PRINT "+";
```

```

ELSEIF x = 24 AND tim <= mid THEN
    ch$ = ""

ELSEIF ch$ > CHR$(47) AND ch$ < CHR$(58) AND x <= 33 THEN
    result$(item, index) = ch$
    LOCATE ypos, x
    PRINT ch$
    x = x + 3
    index = index + 1
    IF x = 21 THEN x = 24
    IF x < 36 THEN LOCATE ypos, x: PRINT "+";
END IF
LOOP
RETURN

PREPDATA:
    FOR item = 1 TO 12
        FOR index = 1 TO 9
            result$(item, index) = " "
        NEXT index
    NEXT item
RETURN

KILLVOICE:
    id1 = 1
    id2 = 2
    CALL vp620(id1, vstop)
    CALL vp620(id2, vstop)
    CALL vp620(id1, vpend)
    CALL vp620(id2, vpend)
RETURN

WRITEDATA:
    OPEN "b:answers\DLT2" + test$ + code$(1) + ".ans" FOR OUTPUT AS #1
    FOR item = 1 TO 12
        FOR index = 1 TO 9
            PRINT #1, result$(item, index);
        NEXT index
        PRINT #1,
    NEXT item
    CLOSE #1: 'diff! = diff! / csub!
    'OPEN "b:answers\DLT2" + test$ + code$(1) + ".vld" FOR OUTPUT AS #1
    'FOR I = 1 TO event: PRINT #1, rt!(I): NEXT I: PRINT #1, diff!
    'CLOSE #1
RETURN

PRACTICE:
    missed = 0
    mid = 16: EOTEST = 25
    item = 1: flag = 0
    pracresult$(1) = "349014379"
    pracresult$(2) = "638153492"

```

```

GOSUB PRACINST
DO UNTIL item = 3
    tries = 0
    work$ = STR$(item)
    work$ = RIGHT$(work$, LEN(work$) - 1)
    lftfile$ = dir$ + "PracLf" + work$ + ".spc"
    ritfile$ = dir$ + "PracRt" + work$ + ".spc"
    DO
        tries = tries + 1
        IF item = 1 AND tries = 1 THEN
            CLS
            LOCATE 13, 9
            PRINT "PLEASE WATCH THIS TRIAL"
            t! = TIMER: DO WHILE t! + 4 > TIMER: LOOP
        END IF
        GOSUB PLAYTEST
        GOSUB DRAWScreen
        LOCATE 11, 16
        PRINT "PRACTICE " + work$;
        IF item = 1 AND tries = 1 THEN
            x = 6: ypos = 14: interval! = 2.51
            LOCATE ypos, x: PRINT "+"
            LOCATE 18, 3
            PRINT " Listen through your RIGHT ear."
            t! = TIMER: DO UNTIL t! + 7.95 < TIMER: LOOP
            FOR index = 1 TO 9
                LOCATE ypos, x
                PRINT MID$(pracresult$(1), index, 1)
                x = x + 3
                IF x = 21 THEN
                    x = 24
                    LOCATE ypos, x
                    PRINT "+"
                    interval! = .95
                    t! = TIMER: DO UNTIL t! + 3 < TIMER: LOOP
                    LOCATE 18, 3
                    PRINT " Listen through your LEFT ear. "
                    t! = TIMER: DO UNTIL t! + 2.25 < TIMER: LOOP
                END IF
                IF x < 36 THEN
                    LOCATE ypos, x
                    PRINT "+"
                END IF
                t! = TIMER: DO UNTIL t! + interval! < TIMER: LOOP
            NEXT index
            GOSUB KILLVOICE
            t! = TIMER: DO UNTIL t! + 5 < TIMER: LOOP
            GOSUB PRACINST2
            CLS
            GOTO 5
        END IF
    DO: a$ = INKEY$: LOOP WHILE a$ <> ""

```

```

GOSUB READNWRITE
flag = -1
FOR index = 1 TO 9
    IF MID$(pracresult$(item), index, 1) <> result$(item, index) THEN flag = 0
NEXT index
IF flag THEN RETURN
t! = TIMER: DO UNTIL TIMER > t! + 2: LOOP
GOSUB KILLVOICE
t! = TIMER: DO UNTIL TIMER > t! + 2: LOOP
IF tries > 2 THEN flag = -1
5    LOOP UNTIL flag
    item = item + 1
    LOOP
    GOTO BOMB
END

INIT:
RANDOMIZE (TIMER)
h = 159: ky! = 20: r = 15: pi! = 3.14159: aspect! = 320 / 200: csub! = 0: diff! = 0
centx! = STICK(0): centy! = STICK(1)
ON STRIG(0) GOSUB PROCTRIG
ON STRIG(4) GOSUB PROCTRIG
RETURN

MAIN:
GOSUB DOSTIK: GOSUB ADDCHAOS: GOSUB DOEVENT: csub! = csub! + 1: diff! = diff! +
ABS(ky! - y! - 20)
STRIG(0) OFF
STRIG(4) OFF
LINE -(h - xl, ky! - y!), 0, , &HFFFF
ky! = ky! + vaxis! + dky!
thetal = thetal + dthetal + phi!
IF ABS(ABS(thetal) - (pi! / 2)) < pi! / 16 THEN thetal = SGN(thetal) * pi! / 2.5
xl = r * COS(thetal) * aspect!: y! = r * SIN(thetal) * aspect!
IF ky! > 40 THEN ky! = 40 ELSE IF ky! < 0 THEN ky! = 0
LINE (135, 20)-STEP(48, 0), 3, , &HF0F0
LINE (h - xl, ky! - y!)-(h + xl, ky! + y!), 3, , &HFFFF
FOR ii = 1 TO 100: NEXT ii
IF inprogress AND dir THEN
    offset = INT(TIMER - start!): LOCATE oy%, ox% + (offset - 1) * dir
    PRINT " ": LOCATE oy%, ox% + offset * dir: PRINT "o"
    dir = SGN(ABS(offset - ABS(20 - ox%))) * SGN(20 - ox%)
END IF
STRIG(0) ON
STRIG(4) ON
RETURN

DOSTIK:
phi! = CINT(STICK(0) - centx!) * pi! / 3000
vaxis! = CINT(STICK(1) - centy!) / 75
RETURN

```

ADDCHAOS:

```
IF ABS(theta!) < pi! / 16 THEN targettheta! = RND(1) * pi! - (pi! / 2)
IF ABS(ky! - 20) < 1.25 THEN targetky! = RND(1) * 40
dtheta! = RND * SGN(theta! - targettheta!) * pi! / 400
dky! = RND * SGN(ky! - targetky!) * .15
RETURN
```

DOEVENT:

```
IF RND(1) > .005 OR inprogress THEN RETURN
offset = 0
event = event + 1
ox% = RND(1) * 20 + 10: oy% = RND(1) * 3 + 2
LOCATE oy%, ox%: PRINT "o": start! = TIMER
dir = SGN(20 - ox%)
inprogress = -1
RETURN
```

PROCTRIG:

```
IF inprogress THEN inprogress = 0 ELSE RETURN
BEEP
finish! = TIMER
rt!(event) = finish! - start!
LOCATE oy%, 8: PRINT " "
RETURN
```

INSTRUCTIONS:

```
DEF SEG = 0: POKE &H417, PEEK(&H417) OR 32: DEF SEG
SCREEN 1: CLS
LOCATE 9, 9
PRINT "DICHOTIC LISTENING TEST"
LOCATE 16, 5: PRINT "PRESS THE SPACE BAR TO CONTINUE"
GOSUB READKEY
CLS : SCREEN 2: SCREEN 0
LOCATE 4
PRINT TAB(10); " The purpose of the following tests is to measure"
PRINT TAB(10); "your ability to pay attention to what you are hearing"
PRINT TAB(10); "in one ear while ignoring what is occurring in the"
PRINT TAB(10); "opposite ear. During the tests, you will hear a series"
PRINT TAB(10); "of numbers and letters of the alphabet in one ear, and"
PRINT TAB(10); "a different series of numbers and letters in the other"
PRINT TAB(10); "ear. Masking sounds will also be occurring in both ears"
PRINT TAB(10); "throughout the tests."
LOCATE 14
PRINT TAB(10); " Your task will be to identify only the NUMBERS"
PRINT TAB(10); "that you hear in a given ear while disregarding the"
PRINT TAB(10); "numbers and other sounds being spoken to you in the"
PRINT TAB(10); "opposite ear. The ear that you pay attention to is"
PRINT TAB(10); "determined by a LEFT or RIGHT command given at the"
PRINT TAB(10); "beginning and in the middle of each test."
LOCATE 24, 21: COLOR 16, 7: PRINT "PRESS THE SPACE BAR TO CONTINUE"; : COLOR 7,
0
GOSUB READKEY
```



```

CLS
LOCATE 2
PRINT TAB(10); "    For example, if you hear the word LEFT, you are to"
PRINT TAB(10); "concentrate on the NUMBERS that you hear in your LEFT"
PRINT TAB(10); "ear. Other sounds that you hear should be ignored. "
PRINT TAB(10); "And likewise when you hear the word RIGHT, you are to"
PRINT TAB(10); "focus your attention on the NUMBERS that are being"
PRINT TAB(10); "spoken in your RIGHT ear. You should type these"
PRINT TAB(10); "NUMBERS on the keypad as you hear them. The numbers"
PRINT TAB(10); "will be displayed on the screen in the appropriate box"
PRINT TAB(10); "as you input them. If you make a mistake, use the"
PRINT TAB(10); "back-space key to correct it."
LOCATE 14
PRINT TAB(10); "Note:  'Oh' is considered a letter; 'Zero' is a number."
PRINT
'PRINT TAB(10); "Note:  If for some reason a test ends without all of"
'PRINT TAB(10); "    the boxes being filled simply press the space"
'PRINT TAB(10); "    bar, the '+' key, or the ENTER key to advance"
'PRINT TAB(10); "    to the next test."
PRINT TAB(10); "Note:  Please make sure that the 'Num Lock' light"
PRINT TAB(10); "    is illuminated on the keyboard."
PRINT TAB(10); "    (If it isn't, press the 'Num Lock' key above"
PRINT TAB(10); "    the numeric keypad)."
LOCATE 21, 1
PRINT TAB(10); "PLEASE INSURE THE HEADPHONE SWITCH IS IN THE 'S' POSITION."
PRINT TAB(10); " PLACE THE HEADPHONES ON (RED EARCUP ON THE RIGHT EAR)."
LOCATE 24, 21: COLOR 16, 7
PRINT "PRESS THE SPACE BAR TO CONTINUE.";
GOSUB READKEY

'PRINT "    During the DLT, a joystick task must also be performed."
'PRINT
'PRINT "    The joystick task consists of keeping an artificial horizon"
'PRINT "    lined up with a horizon line.": PRINT
'PRINT "    At intervals, a target will appear and begin to move toward"
'PRINT "    the center of the screen. When this occurs, press one of"
'PRINT "    the fire buttons on the joystick."
'PRINT : PRINT TAB(19); : COLOR 16, 15: PRINT "PRESS ANY KEY WHEN YOU ARE
READY TO BEGIN"; : COLOR 15, 0
'DO WHILE INKEY$ = "": LOOP
SCREEN 2: SCREEN 0
RETURN

BOMB:
IF BOMB = 1 THEN RETURN 15
CLS
LOCATE 7, 9
PRINT "There has been a problem."
LOCATE 11, 6
PRINT "Please contact the experimenter."
GOSUB READKEY
GOSUB KILLVOICE

```

```
BOMB = BOMB + 1
RETURN MAINBODY
```

PRACINST:

```
SCREEN 2: SCREEN 0
LOCATE 6
PRINT TAB(9); "The following exercise is a demonstration of a PRACTICE test."
LOCATE 9
PRINT "  This exercise will demonstrate the basic format of ";
PRINT "the remaining tests."
PRINT
PRINT "  "
LOCATE 23, 26: COLOR 16, 7
PRINT "PRESS THE SPACE BAR TO BEGIN"
GOSUB READKEY
SCREEN 1
```

RETURN

PRACINST2:

```
SCREEN 2: SCREEN 0
LOCATE 6
PRINT TAB(15); "When you hear the second LEFT or RIGHT command, the"
PRINT TAB(15); "cursor will AUTOMATICALLY move to the second group"
PRINT TAB(15); "of boxes, if it is not already there."

LOCATE 23, 26: COLOR 16, 7
PRINT "PRESS THE SPACE BAR TO BEGIN"
GOSUB READKEY
SCREEN 1
```

RETURN

CHEKSTAT:

```
CALL vp620(id1, s, e, sec, hun, o, vpstatus)
sec = sec - 5!
IF sec / 33! = CINT(sec / 33!) THEN baseline = sec
tim = sec - baseline
LOCATE 1, 1: PRINT tim
```

RETURN

{Scoring Algorithm for the DLT}

```
dltitems = 0
total = 0
```

```
OPEN pans$ + test1$ + test2$ + key$ + SUBJECT$ + ".ans" FOR INPUT AS #1
OPEN pkey$ + "dlt2" + key$ + ".key" FOR INPUT AS #2
```

```
DO WHILE (NOT EOF(1) AND NOT EOF(2))
```

```
    dltitems = dltitems + 1
```

```

INPUT #1, answer$
INPUT #2, dltkey$

IF MID$(dltkey$, 1, 1) = MID$(answer$, 1, 1) THEN
    correct(1) = 1
ELSEIF MID$(dltkey$, 2, 1) = MID$(answer$, 1, 1) THEN
    correct(2) = 1
END IF

IF MID$(dltkey$, 5, 1) = MID$(answer$, 5, 1) THEN
    correct(5) = 1
ELSEIF MID$(dltkey$, 4, 1) = MID$(answer$, 5, 1) THEN
    correct(4) = 1
END IF

IF MID$(dltkey$, 6, 1) = MID$(answer$, 6, 1) THEN
    correct(6) = 1
ELSEIF MID$(dltkey$, 7, 1) = MID$(answer$, 6, 1) THEN
    correct(7) = 1
END IF

IF MID$(dltkey$, 9, 1) = MID$(answer$, 9, 1) THEN
    correct(9) = 1
ELSEIF MID$(dltkey$, 8, 1) = MID$(answer$, 9, 1) THEN
    correct(8) = 1
END IF

FOR j = 2 TO 4
    IF MID$(dltkey$, j, 1) = MID$(answer$, j, 1) THEN
        correct(j) = 1
    ELSEIF MID$(dltkey$, j - 1, 1) = MID$(answer$, j, 1) THEN
        correct(j - 1) = 1
    ELSEIF MID$(dltkey$, j + 1, 1) = MID$(answer$, j, 1) THEN
        correct(j + 1) = 1
    END IF
NEXT j

FOR j = 7 TO 8
    IF MID$(dltkey$, j, 1) = MID$(answer$, j, 1) THEN
        correct(j) = 1
    ELSEIF MID$(dltkey$, j - 1, 1) = MID$(answer$, j, 1) THEN
        correct(j - 1) = 1
    ELSEIF MID$(dltkey$, j + 1, 1) = MID$(answer$, j, 1) THEN
        correct(j + 1) = 1
    END IF
NEXT j

FOR j = 1 TO 9

```

```
total = total + correct(j)
correct(j) = 0
NEXT j
```

LOOP

CLOSE 1: CLOSE 2

PCORRDLT = 100 * total / (dlitems * 9)

RETURN